USE OF A Q&P STEEL FOR PRODUCING A SHAPED COMPONENT FOR HIGH-WEAR APPLICATIONS

TECHNICAL FIELD

[0001] The invention relates to the use of a Q&P steel for production of a formed component for high-wear applications.

TECHNICAL BACKGROUND

[0002] The wear-resistant steels known from the art are extremely hard in view of their end use and correspondingly have high strength in conjunction with limited ductility. The aim of a high hardness required in a wear-resistant steel is sufficiently high resistance to abrasive wear.

[0003] Conventional wear-resistant steels having high hardness are generally only of limited formability and have, for example, a minimum bending ratio of about r/t=2.5 at a hardness of 400 HB, where r corresponds to the inner radius of the bent portion in the bending of the steel and t to the material thickness of the steel/portion. With increasing hardness, there is a decrease in the bending capacity of the steel and a bending ratio r/t<2.5 is possible only with a high level of complexity, if at all, which means that the further processing of the steel, especially to give components (component parts) of complex shape is impaired or limited to a high degree. It cannot be ruled out that, in the forming/reforming of the wear-resistant steel, depending on the geometry or complexity to be produced, or in the event of further stress in the use of the steel, microcracks/cracks or small cracks will arise in the surface or in the near-surface region of the wear-resistant steel, which can even lead to complete component failure owing to the low ductility.

[0004] Complex, formed components for high-wear applications are not producible from one part with conventional wear-resistant steels owing to their high hardness and limited ductility, and so, in the case of corresponding applications, it is necessary to resort to welded constructions formed from multiple different components or component parts. Especially in the case of production of excavator shovels, such constructions are comparatively heavy and hence the loading volume must be reduced since, for example, the jib of an excavator must not exceed a maximum weight. The welding of conventional wear-resistant steels additionally constitutes a high demand on the execution of the weld bond, and some conventional wear-resistant steels are weldable only with a high level of complexity depending on the alloy elements and contents. In the region of the weld bond, owing to the heating during welding, a zone of a few millimeters in width (zone of thermal influence, WEZ) with reduced hardness and relatively low wear resistance is formed, which is locally prone to failure as a result of stress by comparison with the remainder of the construction.

[0005] Q&P steels, "Quenching and Partitioning" steels, and manufacture for adjustment of their mechanical properties are known from the prior art. These steels that were specially developed for the automobile industry combine high strengths with simultaneously high elongation and are of particularly good suitability as components, particularly for use in crash-relevant regions, since, in the event of an impact/crash, by virtue of their mechanical properties, they are able to optimally dissipate the impact energy by deformation. By way of example, European published specifications EP 2 837 707 A1, EP 2 559 782 A1 and EP 2 930 253 A1 are cited. There is no pointer to provide such steels for high-wear applications in these documents.

SUMMARY OF THE INVENTION

[0006] It is an object of the present invention to provide a Q&P steel with which components having complex geometry can be produced for high-wear applications.

[0007] This object is achieved by the features of claim **1**.

[0008] The inventors have found that, surprisingly, it is possible by the manufacture of the Q&P steels to specifically establish predominantly a proportion of martensite of at least 70 area %, especially of at least 80 area %, preferably of at least 85 area %, in the microstructure, where at least half is annealed martensite, and the remaining balance may consist of one or more proportions of up to 30 area % of ferrite, of up to 30 area % of residual austenite, of up to 30 area % of bainite, of up to 5 area % of cementite, it being possible, according to the alloy elements and microstructure of the Q&P steels, to achieve hardnesses that can be at a level of comparable wear-resistant steels but have a higher forming capacity compared to the wear-resistant steels by virtue of the softer components in the microstructure compared to martensite, it is possible to produce a formed component, especially with complex geometry with excellent wear-resistant properties. The formed component can be produced by bending, edging, deep drawing, etc. The Q&P steel has a hardness of at least 230 HB, especially at least 300 HB, preferably at least 370 HB, more preferably at least 400 HB, further preferably at least 425 HB, especially preferably at least 450 HB. HB corresponds to the Brinell hardness and is determined according to DIN EN ISO 6506-1. Studies have shown that a Q&P steel or a component produced from a Q&P steel, by comparison with a conventional wear-resistant steel or a component of the same hardness class produced from a conventional wear-resistant steel, has comparable abrasion, while, by virtue of the higher forming capacity, a bending angle α of at least 60°, especially at least 75°, preferably at least 85°, more preferably at least 90°, especially preferably at least 95°, determined according to VDA238-100, and/or a bending ratio of r/t<2.5, especially r/t<2.0, preferably r/t<1.5, more preferably r/t<1.0, where t corresponds the material thickness of the steel and r to the (inner) bending radius of the steel, is possible.

[0009] The manufacture of the Q&P steels and the establishment of mechanical properties, especially of the aforementioned microstructure, are known in the specialist field. In a first configuration, the Q&P steel or the component produced from the Q&P steel consists of, aside from Fe and unavoidable impurities from the production, in % by weight:

[0010] C: 0.1-0.3%,

[0011] Si: 0.5-1.8%,

[0012] Mn: 1.5-3.0%,

[0013] Al: up to 1.5%,

[0014] N: up to 0.008%,

[0015] P: up to 0.02%,

[0016] S: up to 0.003%,

[0017] optionally of one or more elements from the group of "Cr, Mo, Ni, Nb, Ti, V, B" with

[0018] Cr: up to 0.4%,

[0019] Mo: up to 0.25%,

[0020] Ni: up to 1.0%

[0021] Nb: up to 0.06%,